

Knowledge Transfer via Maps – Explanation of a Complex Process by Means of Communication Models

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Abstract: The purpose of this essay is to explain the challenge of knowledge transfer via maps by means of communication models and in this way provide a basis for discussion to the cartographic community. The authors discuss different models of communication, challenges, addressees as well as definitions of knowledge transfer, especially in spatial sciences.

Keywords: map, knowledge transfer, communication

1. Introduction

Which possibilities provide maps for knowledge transfer from scientific consignors to miscellaneous addressees? The research project “Unknown Territory? Knowledge transfer in social and spatial sciences” investigates how and under which conditions knowledge transfer between scientists and non-scientists can take place. The operational definition of the term “knowledge transfer” used in this project can be formulated as follows: it is the communication, transmission and transformation of knowledge in the form of research results and intermediate results to actors of different sub-systems of society not included in science. Knowledge transfer between the (individual, collective or corporate) actors should be understood as a mutual exchange, a bidirectional and a feedback process. In the research project, we make a distinction between the transfer of data, information, knowledge and skills. The communication via maps constitutes one possibility of knowledge transfer in the spatial sciences and is one special topic of this research project.

We all know about the increasing use of maps in the one or other scientific discipline, like the cultural sciences. Currently, we see the wish to use maps and graphics for spatially related knowledge and information, especially in health services. These wishes of other disciplines bring us to some crucial

questions for the future of cartography. Who are the map makers today? Who teaches people to produce and – much more important – to critically use maps and other spatial visualizations, and reflect on them? What is the role of cartographers in the future? What is a correct map? How can we ensure that the bidirectional (exchange) process between user and map maker (whoever they are) is possible?

We as map makers are well aware that maps have advantages, but also disadvantages. For instance the differentiated and standardized languages used in maps is an advantage as this helps avoid ambiguity. However, there is also a disadvantage or rather a challenge: the map user must be able to read, understand and interpret the map. But we also know that with GIS and Webmapping systems, professional cartographers are only a small portion of map makers. Our challenge as cartographers must be not only to provide the technical basis and the “right” design for map production. It is much more important to understand the contents, to reflect upon possible different and even critical interpretations, and to teach not only map reading but map interpretation. Our main challenge lies in ensuring that the suggested addressees are reached; this means they have to be taken into account from the very beginning, if possible. And it is our task to produce really addressee-specific maps. For this, we have to learn from already existing experiences in science with knowledge transfer and exchange to provide reduced but complete and correct information, to come back to clear (not simple), esthetically interesting maps with correct contents.

On the one hand, there is the complex process of map production involving different disciplines besides cartography; on the other hand, apart from this interdisciplinary negotiation and communication processes, the challenge consists in reaching addressees outside of the scientific community. Here a special challenge and as well an interest of the project lies in the transfer of knowledge from the social sciences through maps – inter alia because the social sciences are primarily text-based, and there are difficulties inherent in knowledge and information translation into tables, charts and images. Models of communication can help to explain this complex process, furthermore we hope they are of assistance to find solutions for unsolved challenges of map making: e.g. to know and to become acquainted with the map user. In a model captures only a selection of attributes and makes it possible to focus on the essentials. The analysis of established models of communication enables the development of a new integrated model for understanding knowledge transfer in the spatial sciences, for example via maps. On this account, we have chosen models of communication and models of cartographic communication respectively to be presented here and to serve as the basis for the subsequent derivation.

1.1. Models of Communication in Communication Studies

The Shannon-Weaver¹ model of communication provides the basis for most models of communication.

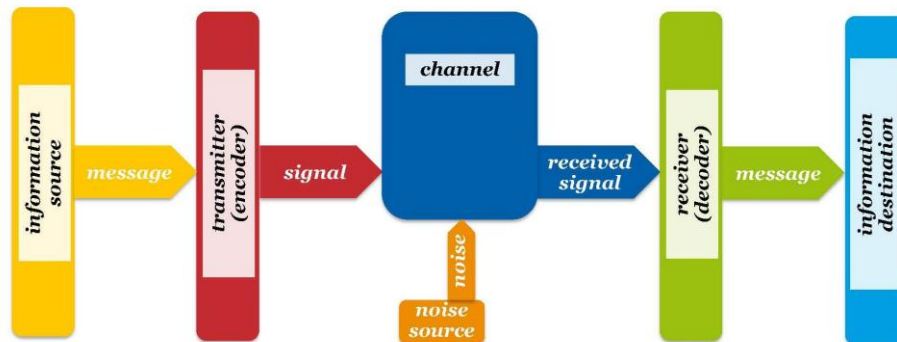


Figure 1. Shannon-Weaver model of communication, illustration by the authors based on Shannon/Weaver (1963)

Originally technical and unidirectional, this model has been constantly refined and adapted to various purposes ever since. The initial Shannon-Weaver model represents the transmission of a message chosen by an information source and sent by a transmitter. The message, encoded by the transmitter as a signal, is transmitted through a channel and possibly distorted by a noise. The receiver converts the received signal back into a message which finally reaches the information destination. This model shows the principal constituent sectorial aspects and elements of the process of communication in a clear and simple manner.

Although knowledge transfer is clearly not a unidirectional process, the ambiguous role of the cartographer plus his or her complex task can be clarified by means of this model. The cartographer in his ambivalent role as transmitter and knowledge producer must be able to translate the message: in addition to the availability of data, its selection is essential. Here, the issue is to what extent subjectivity is an integral significant part of the selected data, information and knowledge. Different scientific sources can be used if several disciplines are integrated into the process of map production.

¹ Claude Elwood Shannon and Warren Weaver

If the addressees are reached directly, they are represented in this model both as receivers and the information destination; if disseminators, such as teachers or scientific journalists, are involved, the addressees are represented as the information destination. In this context, the filtering process as well as the discussion of information loss and information gain through cartographic communication (Rataijski 1977) is crucial.

To highlight and elucidate the characteristics of maps in the process of knowledge transfer, it is necessary to consult a further communication model. Supposing that every subsystem of a language, and hence also scientific languages, includes its own inventory of signs (Coulmas 1982). The Organon² model, formulated by Bühler (1934) constitutes another important aspect which can help explain the characteristics of maps and the process of knowledge transfer via maps. Bühler's Organon model explains the term "sign" in natural languages and at the same time serves as a model of communication.

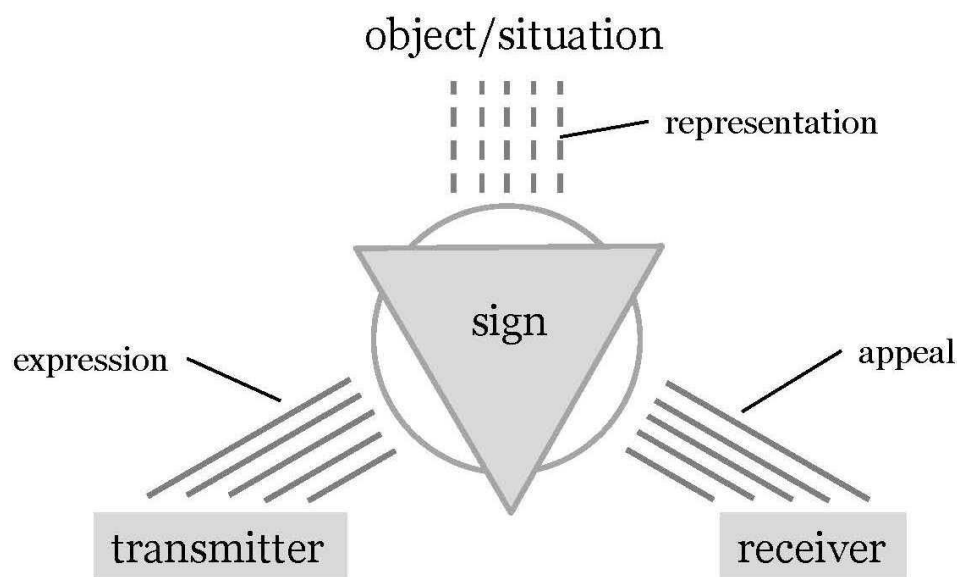


Figure 2. Organon model, formulated by Karl Bühler, illustration by the authors based on Bühler (1934)

The circle embodies the physical vehicle of the sign (for example, an acoustic noise phenomenon), the triangle denotes the sign's function, and the parallel lines symbolize its semantic functions. The sign is related to the

² Greek: ὄργανον meaning instrument, tool, organ

transmitter and to the receiver as well as to the object or situation. According to Bühler (1934), the sign of a language has an expression function, a representation function and an appeal function. The object of research itself as well as the channel or perhaps the carrier of the sign – e.g. the map – expresses, represents and appeals simultaneously. To understand the semiotic³ structure of maps (Schmauks/Nöth 1998), it is important to analyze the expression, representation and appeal functions of a map. The following still holds: “The representational nature of maps ... is often ignored” (MacEachren 1995: V)

While the Shannon-Weaver model explains the stereotypical process of communication, and Bühler's Organon model focuses on the sign viz. the characteristics of maps, a third model of communication chosen by the authors deepens the role of transmitter and receiver. This model, developed by Löffler, is fundamental to understanding the process of knowledge transfer through maps, that is, through the making and consuming of maps, and in particular the background and role of the cartographer and the miscellaneous addressees (termed “speaker” and “listeners” by Löffler).

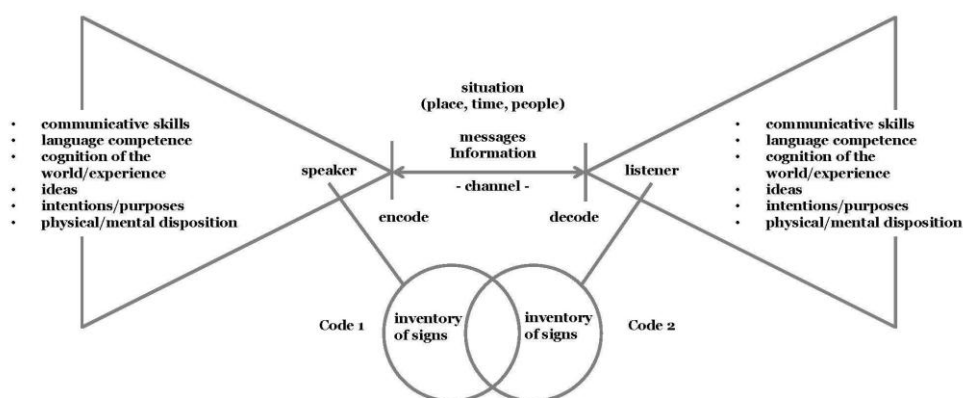


Figure 3. Model of communication, illustration by the authors based on Löffler (1991)

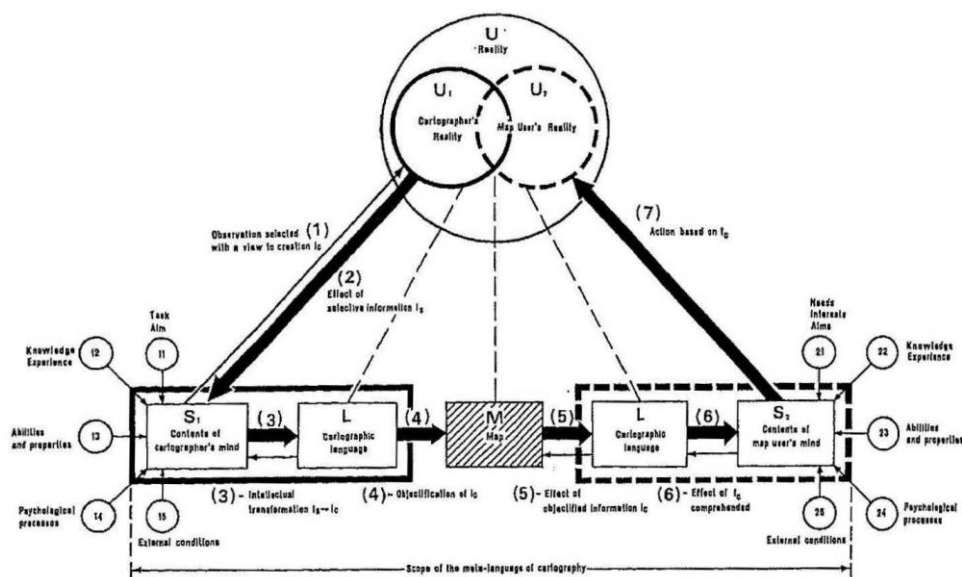
Löffler (1991) emphasizes the relevance of the situation (place, time, people) of the speaker as well as the listener as well as of their context for the quantity and quality of communication (Fig. 3).

³ Semiotics: theory of signs (cf. Eco 1976)

Considering the different contexts of a scientific cartographer and a non-scientific map user, the challenge of communication and thus the challenge of knowledge transfer becomes evident. Has the cartographer, on one side, the communicative skills, the “language” competences, the disposition and expertise to reach the addressee? And does the knowledge transfer to lay people in fact serve his purposes and is it in line with his ideas and intentions? And, on the other side, that of the cognitive aspect of cartography: is the addressee able to read, understand, interpret and critically scrutinize the map?

1.2. Models of Communication in Cartography

Cartographers have developed own concepts and models of communication over recent decades, which use ideas from the communication sciences. Koláčný's model of communication was precursory and provides a valuable basis of the visual representation of knowledge transfer in cartography. Koláčný explains the production and the utilization of maps as a complex and as best coherent “process of activities and operations with feedback circuits on various levels [...] in which cartographic information originates, is communicated, and produces an effect” (Koláčný 1969).



U1	reality (the universe) represented as seen by the cartographer	S2	the subject consuming the map, i.e. the map user
S1	the subject representing reality, i.e. the cartographer	U2	reality (the universe) as seen by the map user
L	cartographic language as a system of map symbols and rules for their use	Ic	Cartographic information
M	product of cartography, i.e. the map		

Figure 4. Koláčný's model of communication (1969): "communication of cartographic information"

In his model of communication, Koláčný uses the term "reality" not as an absolute but as a subjective description of veritableness. He describes the map as a derived product of the intersection of two universes (Wardenga 2012) meaning that the map user and the map producer operate in different contexts as illustrated in Figure 4:

- external condition (15/25)
- psychological process (14/24)
- abilities and properties (13, 23)
- knowledge experience (12, 22) as well as
- task and aim (11) and needs, interests, aims (21) respectively.

Koláčný's model deviates from the Shannon-Weaver model in terms of the distinction between the information source and the transmitter as well as the receiver and the information destination. Koláčný attaches more importance to the cartographic language. In the next chapters, the authors will focus on these two sections – the side of the consignor and the side of the addressee.

2. Knowledge Transfer in Spatial Sciences

Koláčný's model does not deepen several fields that reflect the developments of the last decades and are important in social and spatial sciences: e.g. the inter- or even the transdisciplinary (Mittelstraß 2005) production of maps, the differentiation between receiver and information destination and hence the role of intermediaries as well as the difficulties and varieties in the feedback process from the map user to the cartographer.

2.1. Definitions

Originally the term "transfer" was used in economic and business sciences, but was soon introduced to history, sociology, political science and literature, among others. Knowledge transfer is often mentioned in conjunction with technology transfer, but their relation to each other has been interpreted diversely. Technology transfer is already an established term which often emerges in the context of industry-oriented research (Pechmann et al 2010) and often includes knowledge transfer (IPCC 2010). But technology transfer is also defined as one part of knowledge transfer; we could say that technology is constituted and materialized knowledge. In this context, it is interesting to discuss the fact that cartography is defined technologically as well as scientifically.

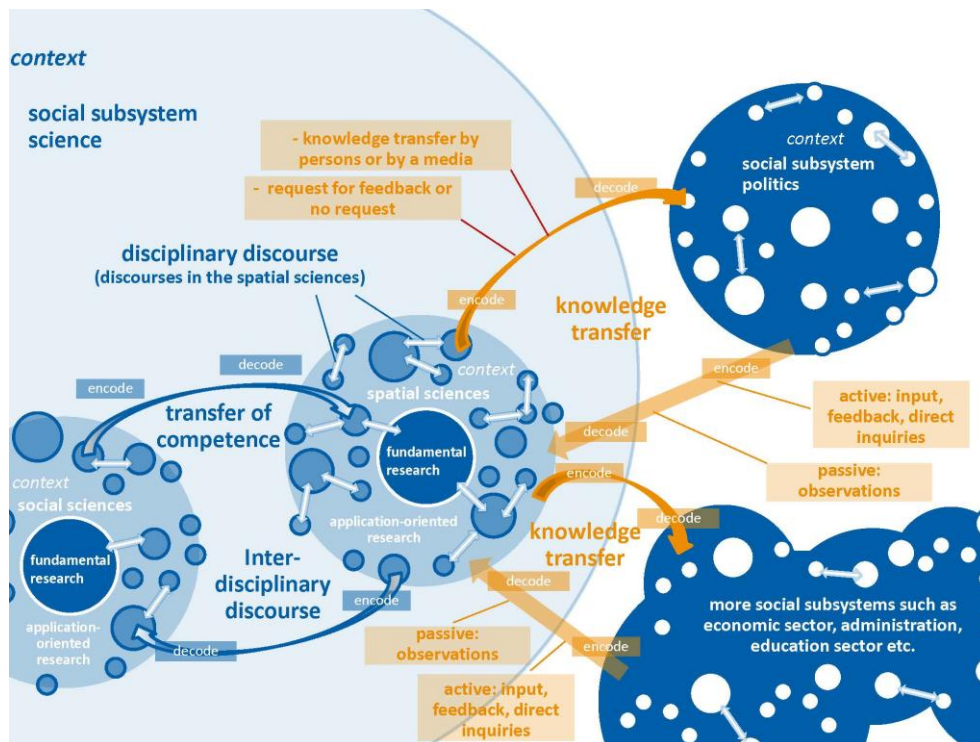


Figure 5. Model of knowledge transfer, illustration by the authors

A scientist communicates within his or her scientific discipline (Stichweh 1994), but is in many instances also interacting with other disciplines. The term interdisciplinary communication describes an exchange of knowledge between several cooperating scientists of various disciplines. Knowledge transfer, which, in our understanding, is the interaction with actors of different subsystems of society, is an additional kind of communication as represented in the model (see Figure 5). The feedback loops and processes of knowledge transfer may consist of direct requests and indirect input; in particular, the non-institutionalized general public has hardly any direct influence on science (Stichweh 2005). The communication via maps constitutes merely one possibility of knowledge transfer in the spatial sciences.

2.2. Addressees

The essential dimension in knowledge transfer is the addressee – in contrast to the intra- and interdisciplinary scientific communication, where the addressee acts in the same subsystem as the consignor.

To focus on the addressees is not a new approach. Already in the 1970ies, Robinson demanded that “in communication the psychology of the map reader should set upper and lower bounds on the cartographer’s freedom of

design” (Robinson 1977). Since then, subjects such as “expert-novice differences, the child’s understanding of maps, how people learn and remember maps” (Crampton 2001) have become increasingly important. Additionally, cognitive aspects have also become more and more relevant.

target areas	target groups	possible intermediary
specialist public	administration (executive)	scientists
	planning practice	
	other branches (e.g. real estate)	
	prof. associations	
	NGOs	
politics	legislature: international, national (fed. government &	political advisors, advocacy groups
	corporation: regional (districts and municipalities), NGOs	
schools/academies	pupils	teachers, textbook commissions, publishing houses, media
	adult students	
public	general public	science journalists, artists, museum educator

Table 1. Target groups and intermediaries in the spatial sciences

In target-group-specific communication in the spatial sciences, maps play a significant role and can be integrated in the communication with the specialist public, politics, schools, and the general public (see Table 1). In particular, the use of digital maps offers opportunities and comprises changes as well as innovations. The changes in behavior – of users as well as of producers – comprise the use of different information and data media for perception and utilization, open source technology, crowd sourcing (Sui/Elwood/Goodchild 2013) and interactive maps, to name just a few. In the context of knowledge transfer, these technical and social innovations (Howaldt/Schwarz 2010) offer numerous opportunities; for instance, they allow for a higher human-map interaction, reach a wider audience and make it possible to change from a traditional frontal teaching to hands-on techniques (MacEachran 1994). In addition this development allows a better assessment of user activities directly as well as indirectly.

3. Challenges for knowledge transfer by maps and possible solutions

There are different obstacles or barriers – called “noise” by Shannon/Weaver (1949) – in the process of knowledge transfer in the spatial sciences in general and via maps in particular. To a non-negligible extent it is presumably the current system of reputation in science that supports the intradisciplinary scientific communication but not necessarily the exchange with non-scientific partners (Kulke 2010, 2011, Mevissen/Bötcher 2011). Here the question arises what success actually is and how the success factors are defined.

Löffler points out the relevance of the “situation (place, time, people)” (1991) as well as the significance of “ideas, intentions and purposes” (1991). In this regard, it is important to point out that in knowledge transfer, different forces are at work: opposite the side of the scientific transmitter who “pushes” knowledge towards the public exists the public side itself which requests and enquires – that is, “pulls” –, or not. Furthermore, both sides have their own cycle or rhythm of topicality – they are not congruent, which means a relevant research topic may not necessarily arrest the attention of the public because there are different key focal points at that moment.

The transmission of scientific contents that are complex, ambiguous (Streeck 2010) and not final (merely progress is made in science, cf. Kuhn 1976) is thereby a special challenge. In this context, the question arises whether it is necessary to simplify scientific results for non-scientific addressees, or if it is possible to explain ambiguous results and complex correlations in a clear and comprehensible way. Both the scientist and, for example, a politician, who would prefer for his decisions-making rather an unambiguous recommendation than “bounded rationality” (Simon 1991), act in their own “reality (the universe)” (Koláčný 1969). The question of how to handle this transition region cannot be answered universally, but rather on a case-by-case basis.

Another important aspect lies in the context of the consignor and addressee (Löffler 1991, Koláčný 1969), in particular of the “communicative skills”, “language competence” and “cognition of the world/experience” (Löffler 1991) of the consignor and the addressee. A huge overlap in the “inventory of signs” (Löffler 1991) or the “reality” (Koláčný 1969) between both actors can be considered an advantage for the communication, thus the knowledge transfer via maps. If there is no or only insignificant overlap between them, the context of the actors becomes “noise” as well. This may be one reason for the increasing role of infographics in the context of Infotainment, which

assumes less cartographic knowledge, but might not lead to a correct understanding either.

In this context, the influence that modalities of knowledge generation (fundamental research, inter- or transdisciplinary research) have on the transfer medium and on the success of knowledge transfer are being discussed: if the non-scientific addressee or the addressee of another discipline is already integrated in the process of knowledge production, the knowledge transfer will probably be facilitated.

Another challenge lies in the assessment of transfer. To assess the initiation of the communication process such as the supply of financial and personnel resources and the provision of a conducive institutional framework is feasible. Furthermore, it is possible to assess the communication process itself and the results of the process – this means the material as well as the immaterial outcomes. But the impact, for example, the perception, the adoption and the utilization or the long-term effects and impacts on opinions, attitudes and emotions, is extremely difficult to assess and to associate with one single research project.

The initial impressions of the expert interviews within the project “Unknown Territory” suggest several potential directions to support knowledge transfer. The intrinsic motivation for a scientist to work in the field of knowledge transfer (social commitment e.g.) and the extrinsic motivation (evaluation e.g.) – Koláčný (1969) mentions them, though under different terms (“external condition” or “task and aim”) – play a major role in the support or in the hindrance of transfer (e. g. the current system of reputation).

The initial impressions also suggest that enduring personal contacts to addressees which can be classified as “psychological process” (Koláčný 1969) as well as “experience” (Löffler 1991) are beneficial for knowledge transfer. Against that background, it is of particular interest that the scientist acts in temporary (research projects) and permanent (research institute, research foundation) structures, though these permanent structures are subjectively temporarily as well in the context of temporary contracts. In any event, one impression from our research project is the need to value the extra time, thoughts and work that have been put into a map, as well as into other knowledge transfer media for non-scientific addressees, which is not the case in the current system of reputation in science.

As an alternative to the integrative approach of knowledge transfer, a so-called intermediary can undertake the task of knowledge transfer (Meißner 2001). This function can be performed, for instance, by science journalists (see Table 1). Depending on the task, the focus, and the self-conception, the

intermediary acts as a linear distributor or rather a restructuring disseminator. Assuming that the best knowledge transfer is performed by the agent producing the knowledge, the initial impressions of the expert interviews suggest that if the target group is close to the content of the research, this is more likely to be realizable. On the other hand, in a division of labor-approach, for instance, if the addressee is distant from the content and the scientist doesn't provide the knowledge and skills that are required and prerequisite for knowledge transfer, intermediary people, organizations, or structures could be beneficial.

To some extent, it is possible to communicate complex issues to lay people, and maps are an effective and vivid tool to take up this challenge. In the parallel development of a specialized language and a bulk capable language lies a challenge and an opportunity also in cartography.

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